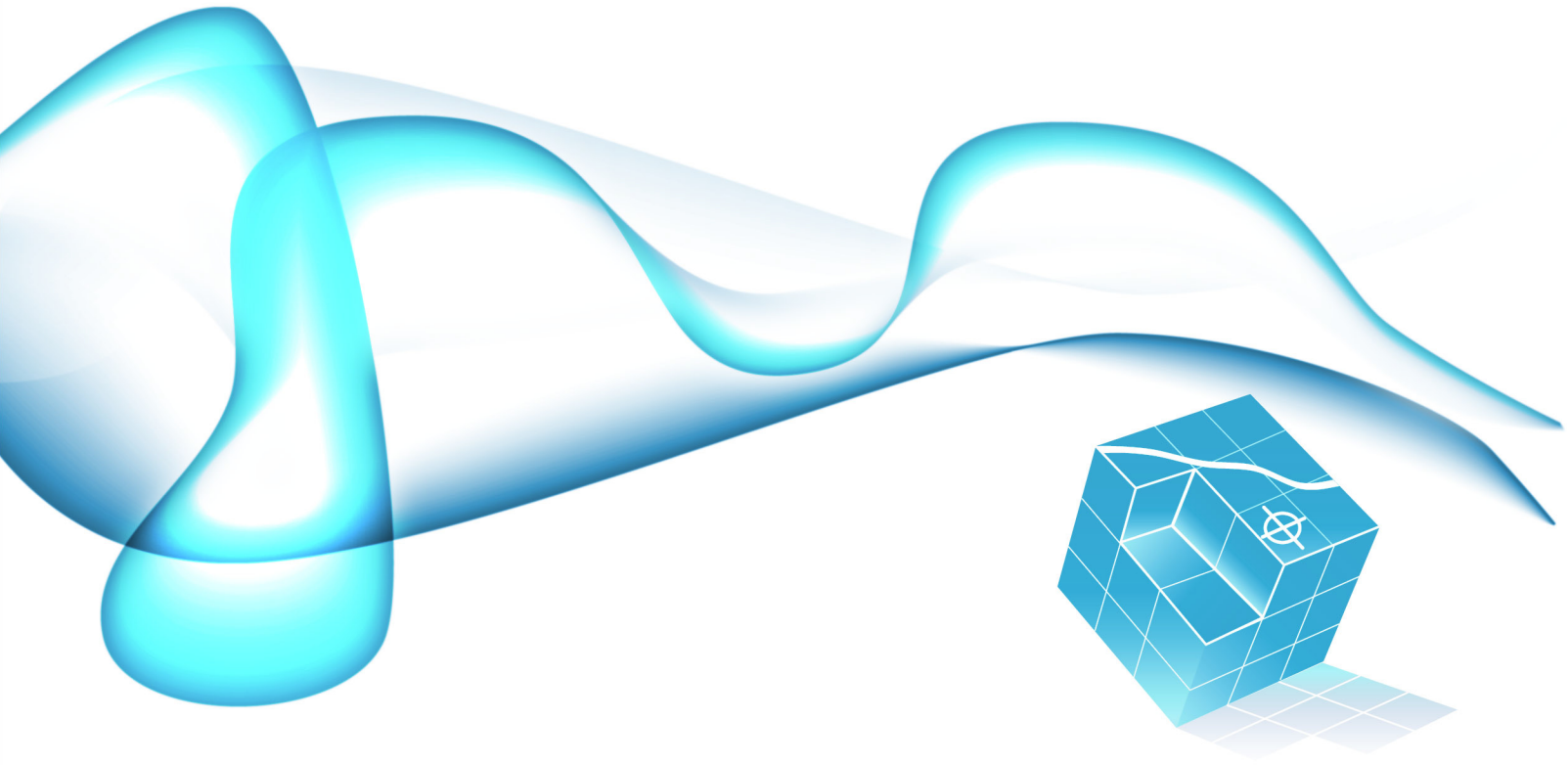
Visual MODFLOW 3D-Builder

Quick Reference Guide



Visual MODFLOW 3D-Builder Quick Reference Guide

Introduction

This document describes the basic use of Visual MODFLOW 3D-Builder and guides you through the general workflow for creating your first conceptual model. It provides "step-wise" instructions on how to create a new project, import data, create structural zones and horizons, define property zones, create boundary conditions, and finally, import your model into Visual MODFLOW.

For more detailed information on all features available in 3D-Builder, please refer to the online help or your User's Manual. This can be accessed by selecting **Help** and then **Help Topics** from the 3D-Builder main menu.

When following this guide, you may use your own data, or you may use the provided sample files located in your **Documents \ 3D-Builder Projects \ Quick Reference Guide Files** folder. This sample data appears in the screen captures of this guide.

Topics

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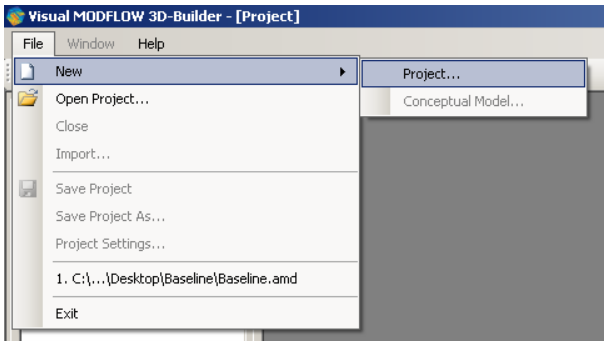
Creating a New Project

1. Start 3D-Builder by double-clicking on the desktop icon  or by selecting **Start / Programs / SWS Software / Visual MODFLOW / Visual MODFLOW 3D-Builder.**

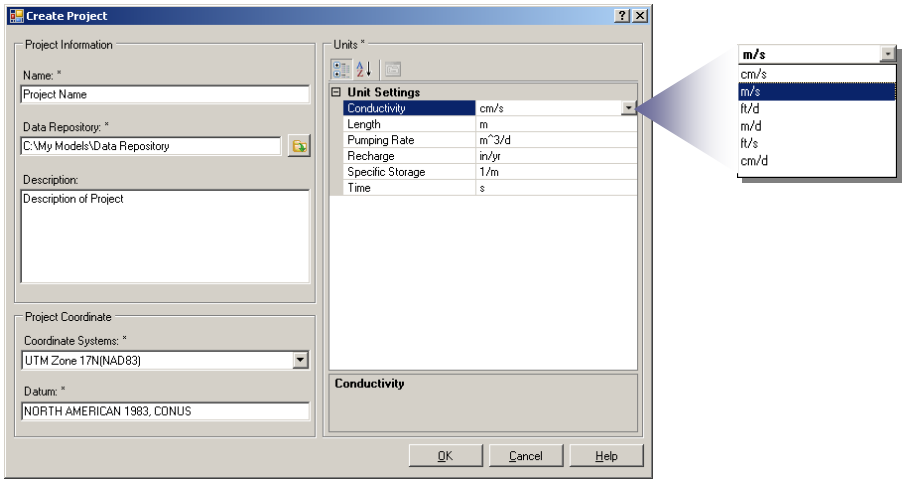
2. From the main-menu, select **File / New / Project**…



Defining Project Settings

1. Enter a unique project name in the **Name** field.
2. Click the **Open** button and select a location on your computer where all project data will be saved.
3. Select the appropriate coordinate system from the **Coordinate Systems** combo box.

The project name cannot contain special characters such as \ / :* ?"< > | .



4. Define the unit system for your project by selecting the appropriate units for each parameter listed in the **Unit Settings** grid. If you do not know this information, you can leave the default settings and modify the units at a later time.

5. Click the **[Ok]** button to save the Project Settings, and complete the projection creation.

   You can edit the project settings at any time by clicking **Project / Settings** from the main menu.

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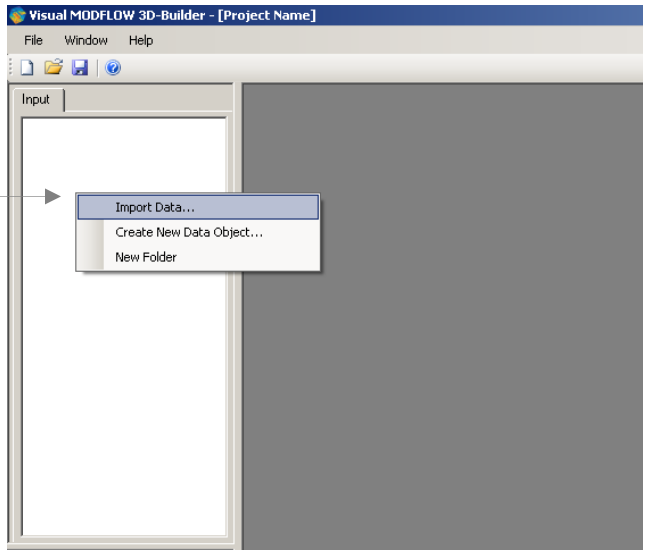
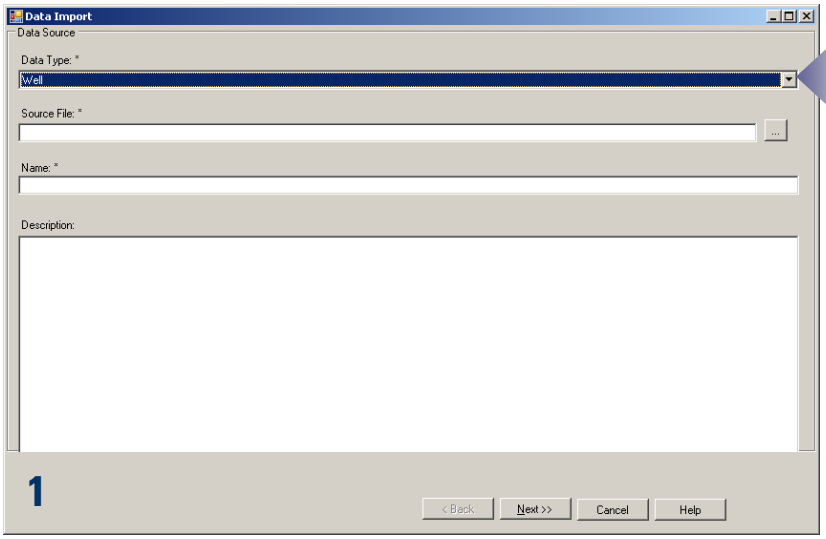
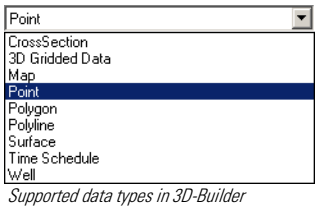
Importing Data

1. Right-click anywhere in the **Input** tab and select **Import Data…** from the pop-up menu, or click **File / Import** from the main menu.



2. The Data Import dialog will appear where you can specify the **Data Type**, **Source File**, **Data Object Name** and **Description** (optional). The supported file formats depend on the selected data type.





Supported data types in 3D-Builder

To see a list of supported file types please see Supported File Types on page 26.

Data Type	Click the button and select the desired data type from the combo box
Source File	Click the button and select the source file from a location on your computer
Name	Type a unique name for the data type

3. Click the **[Next]** button to continue.

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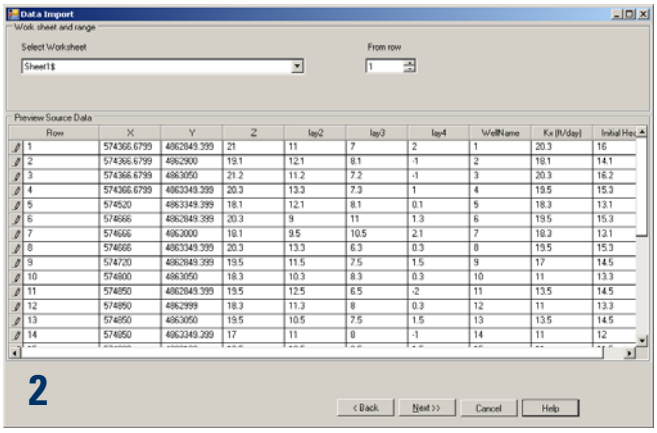
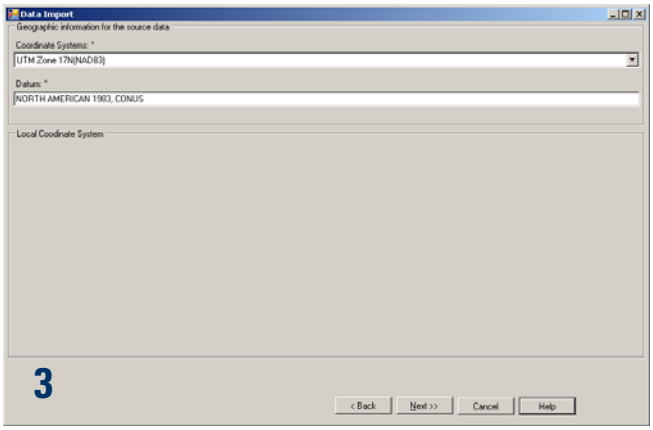
4. The remaining steps may vary slightly depending on which data type is selected. The general workflow is shown below:

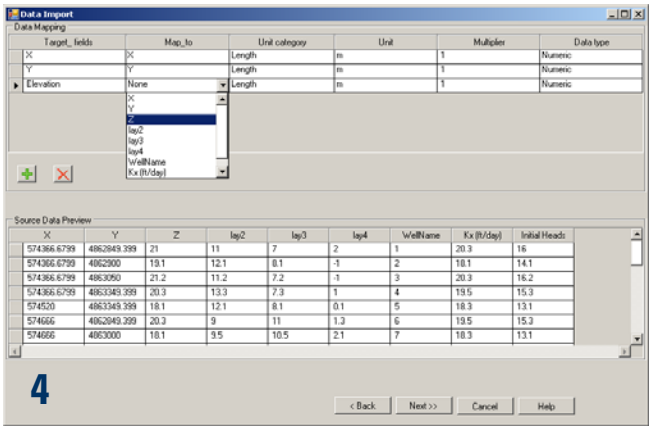
The source file for data shown in the import screen captures is **Points.xls**, located in your **Documents \ 3D- Builder Projects** folder



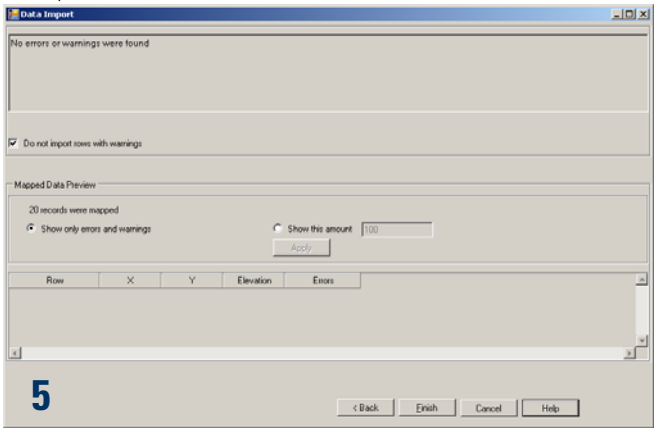
Prepare and preview the source data. This step is only required when importing **Points, Time Schedule** and **Well** data.



Select the coordinate system of the source data. If the coordinate system of the source data is different than the project's coordinate system, a geotransformation will be performed.



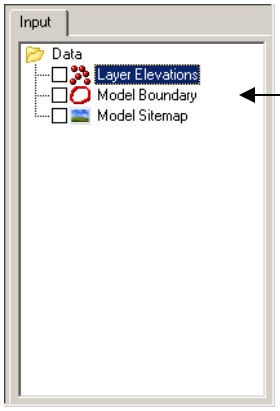
Map the source data fields to the target fields and create attributes. In the **Map_to** column, click in each field, and then select the corresponding target field from the combo box. For each mapped field, specify the **Unit Category**, **Unit**, **Multiplier** and **Data Type**. Click the green **[+]** button to create a new attribute. Attributes can be created for **Wells**, **Polylines**, **Polygons**, **Points** and **Time Schedules**.



In the final step the mapped data is validated. All rows that contain invalid data will be highlighted yellow or red in the **Mapped Data Preview** frame. Select the **Do not import rows with warning** checkbox to exclude this data from the data import.

5. Once imported, the data object will appear in the **Input** tab.

For more information on importing data into 3D-Builder, please refer to Chapter 3 of your User's Manual.



Imported Data

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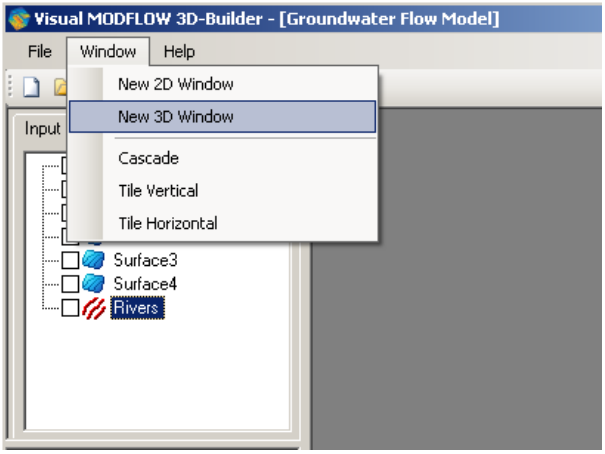
Viewing Imported Data in 3D and 2D

To view your data in a 3D Viewer Window, follow the steps below:

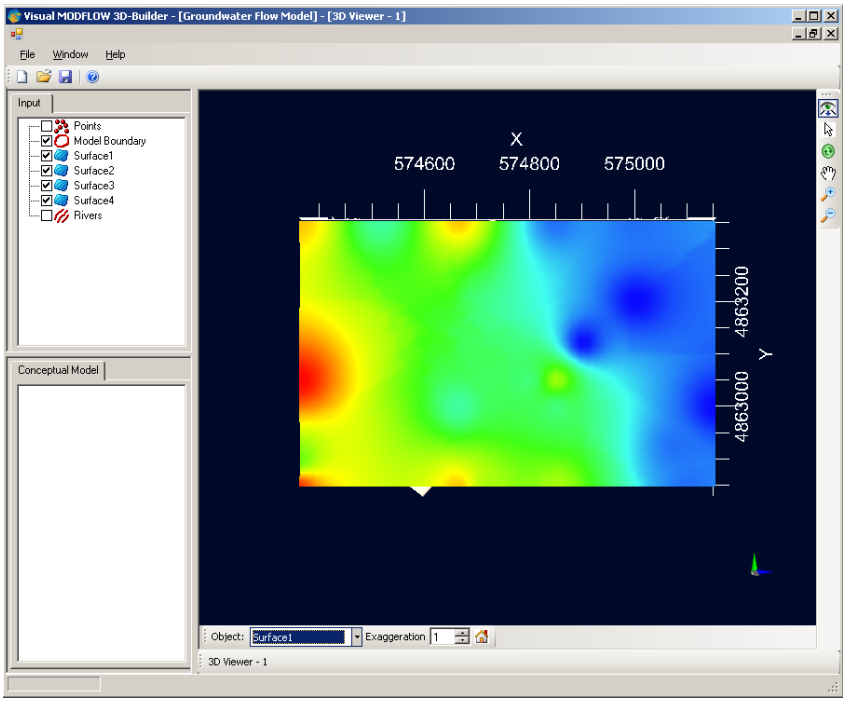
1. From the main menu, click **Window \ New 3D Window**



Most data objects can also be viewed in a 2D planar view. To view your data in 2D, click **Window \ New 2D Window** from the main menu.

Upon clicking, a new 3D Window will appear. You can resize the window by clicking and dragging the window corners, or simply click the ☐ button in the top-right corner to maximize the window.

2. To display imported data in the 3D Viewer, simply select the box ☐ beside the data object name in the input tab so that it appears checked ☑.



Surfaces shown in this screen capture were generated from Points.xls located in your **Documents \ 3D Builder Projects** folder

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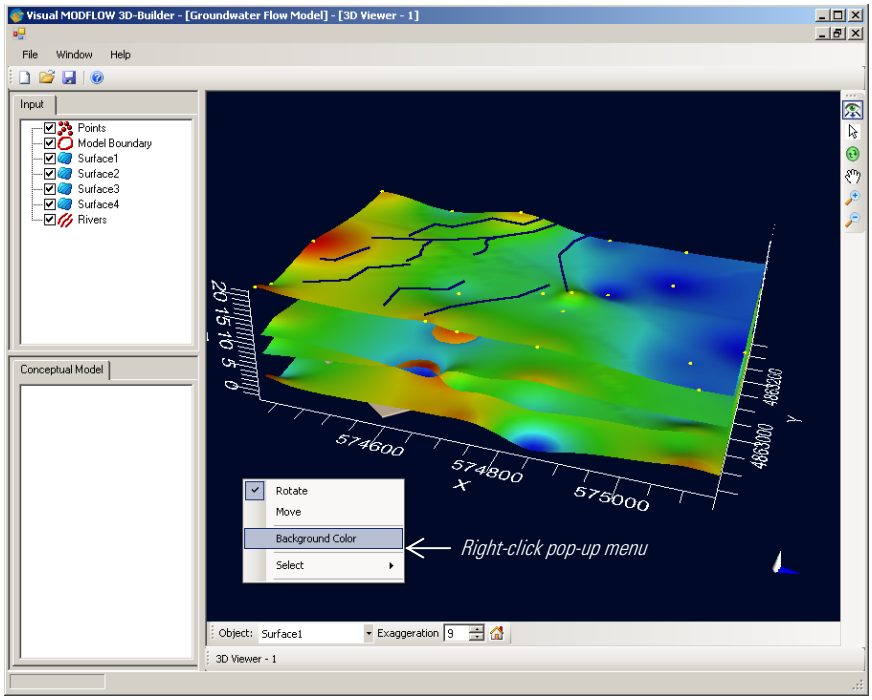
3. Once the data is displayed in the 3D Window, you can zoom in and out, rotate and move the data within the window, using your mouse.



Rotate
Click and hold the left mouse button anywhere in the 3D Viewer Window and move the mouse to rotate the data.

Move
Right-click anywhere in the 3D Viewer Window and select **Move** from the pop-up menu.

Then, click the hold the left mouse button and move the mouse to move the data left, right, up or down.

Zoom
Place your mouse anywhere in the 3D Viewer Window and move your scroll wheel on your mouse forward to zoom in and backwards to zoom out.

You can change the color of the 3D Viewer Window by selecting **Background Color** from the right-click pop-up menu.

4. You can set the vertical exaggeration by entering a value in the **Exaggeration** text field located at the bottom of the 3D Viewer Window, and pressing [Enter] on your keyboard. You can also change the vertical exaggeration using the **Up** and **Down** arrows.

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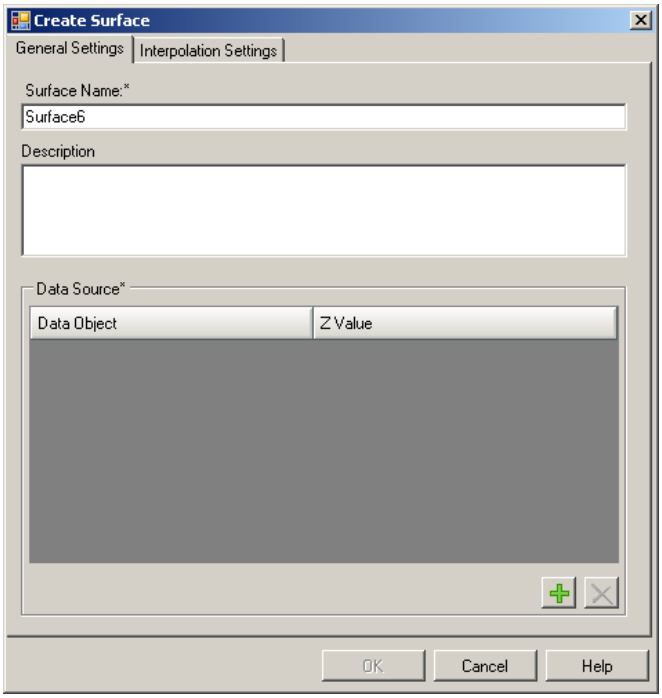
Creating Surfaces from Points

Imported points data objects can be interpolated to create surfaces. These surfaces can then be used to generate horizons for your conceptual model. To create surfaces from a points data object, follow the steps below.

1. From the **Input** tab, right-click anywhere and select the **Create Surfaces…** from the pop-up menu.

2. The **Create Surface** dialog will appear on your screen. Specify the general settings described below.



Surface Name:
Type a unique name for the surface

Description (Optional):
Type a description for the surface.

Data Source:
Surfaces can be generated from one or more points data objects. To add a points data object,

- Click the **Add** button to add a new data source.
- Select the desired points data object from the **Input** tab, and then click the **Blue Arrow** button.
- Under the **Z Value** column, select the desired attribute from the combo box
- Repeat to add additional points data objects.

3. Click the Interpolation **Settings** tab, and specify the desired **Interpolation** method. For more information on the interpolation settings, please refer to your 3D-Builder User's Manual.

4. Click the **[Ok]** button to generate the surface data object. Once generated, a new surface data object will be added to the **Input** tab.

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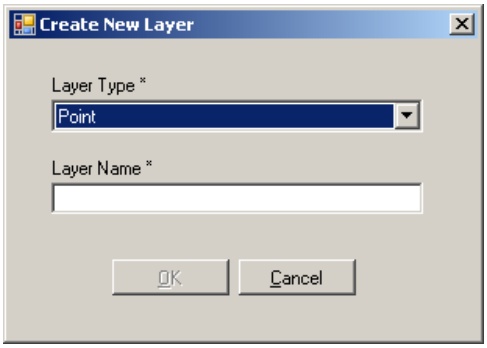
Creating and Drawing a New Data Object

To create a new Point, Polyline or Polygon data object, follow the steps below.

1. From the **Input** tab, right-click anywhere and select **Create New Data Object…** from the pop-up menu**.**
2. The **Create New Layer** dialog box will appear on your screen (shown below). Specify the following settings:



Layer Type:
Select which type of data object to create. Choose between *Point*, *Polyline* and *Polygon*.

Layer Name:
Type a unique name for the data object.

3. Click the **[Ok]** button to create the new data object. A new data object will be added to the **Input** tab.
4. Using the 2D Viewer drawing tools, you can draw the geometry of the new data object. Open a new 2D Viewer window by selecting **Window** \ **New 2D Window** from the main menu.
5. Make sure the new data object is "checked" in the **Input** tab.
6. You can display other data objects in the 2D Viewer while drawing the geometry of the new data object. However, make sure that the new data object is the "active" one by selecting it in the **Layer** combo box, located at the bottom of the 2D Viewer.
7. From the 2D Viewer sidebar, select the  **Pick Mode** button.
8. From the 2D Viewer sidebar, select the  **Edit** button. Various buttons will be added to the 2D Viewer side bar. These buttons allow you to draw points, polygons and polylines in the 2D Viewer. For a complete description of the editing buttons, please refer to the section "Digitizing & Editing Geometry in 2D Viewers" in Chapter 5 of your 3D-Builder User's Manual.
9. Draw the geometry of the data object in the 2D Viewer using the drawing tools.
10. Once you have finished drawing your shape(s), click the  **End Edit** button from the sidebar.
11. Finally, click the  **View Mode** button to set the viewer back to normal viewing mode.

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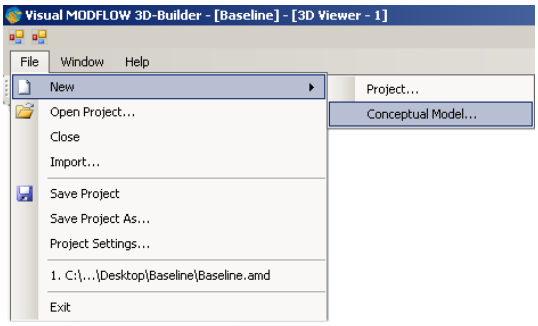
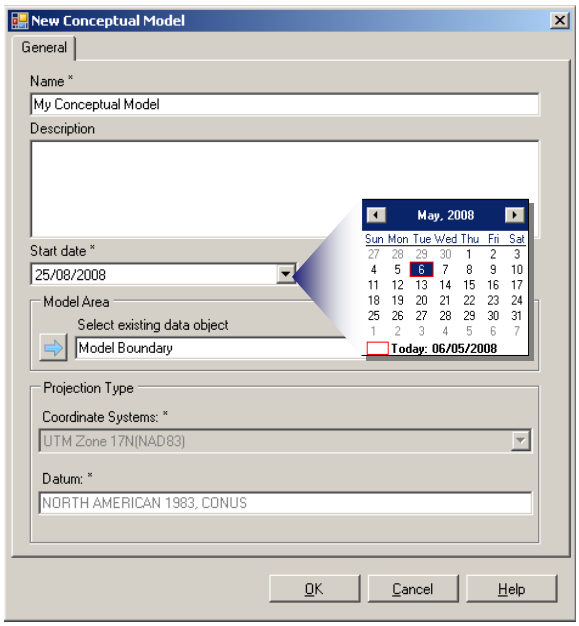
Creating a New Conceptual Model

Once your raw data is imported into 3D Builder, you can create a conceptual model. The minimum data requirements for creating a conceptual model is two surfaces and one polygon that defines the model boundary.

1. From the main menu, select **File \ New \ Conceptual Model…**



2. A **New Conceptual Model** dialog will appear, where you can define the settings for the conceptual model. The **General** settings are described below.



Name
Type a unique name for the conceptual model

Description *(optional)*
Type a description for the conceptual model

Start Date
Select the start date of the conceptual model by clicking on the button and selecting a date from the pop-up calendar.

Model Area
Select a polygon data object from the **Input** tab that represents the boundary of the model area. Once selected, click the button.

Projection Type
By default, the projection type will be the same as the project's projection type, defined in the project settings. This setting is for reference only, and cannot be changed.

3. Once the required data has been entered, click the **[Ok]** button, and a conceptual model tree will be added to the **Conceptual Model** tab.

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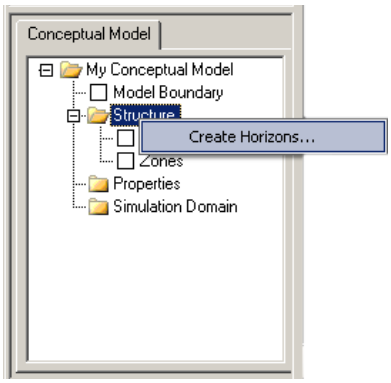
Creating Horizons

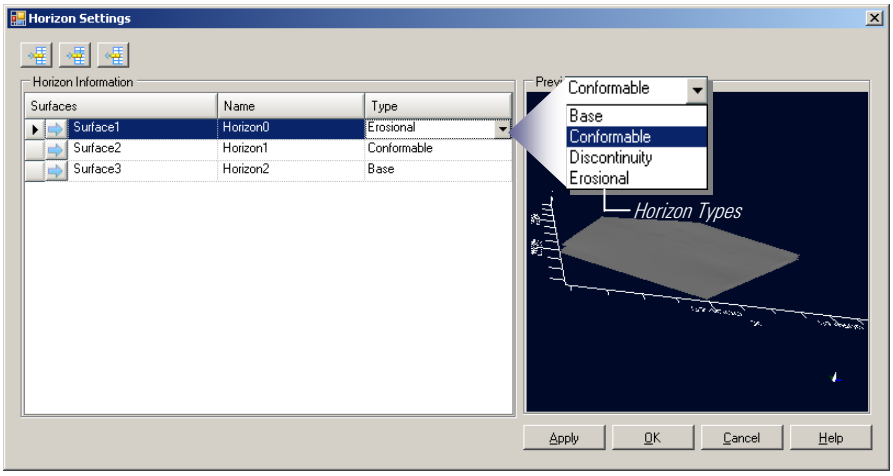
Horizons are stratigraphic layers that form the upper and lower boundaries for structural zones in the conceptual model. Horizons are generated using existing surface data objects in the **Input** tab. To create horizons, follow the step below:

1. From the **Conceptual Model** tree, right-click the **Structure** node and select **Create Horizons…** from the pop-up menu.



2. The **Horizon Settings** dialog will load. Click the **Add** button to add a horizon.
3. Select a surface data object from the **Input** tab and then click the button. Repeat step 2 and 3 for additional horizons. Note: Surfaces must be added according to elevation, starting with the top surface (ground surface) and ending with the bottom surface.

A conceptual model requires *at least* two horizons.



In the **Name** column, type a name for each horizon and select the horizon type from the **Type** column. For more information on the different types of horizons, please refer to the User's Manual.

4. Click the **[Apply]** button to preview the horizons.
5. Click the **[Ok]** button to create the horizons. The created horizons will now appear under the **Horizons** node in the **Conceptual Model** tree.

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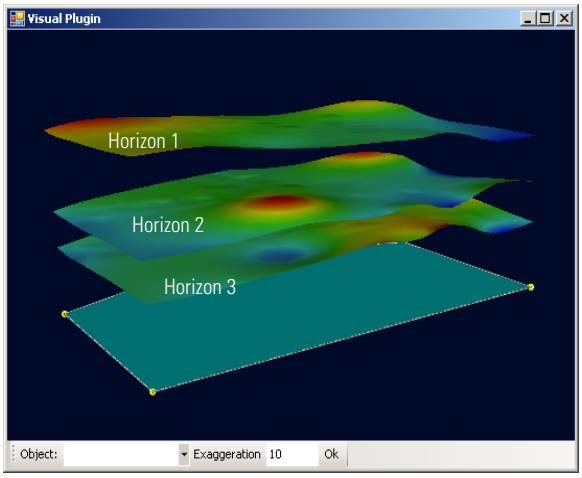
Viewing Horizons

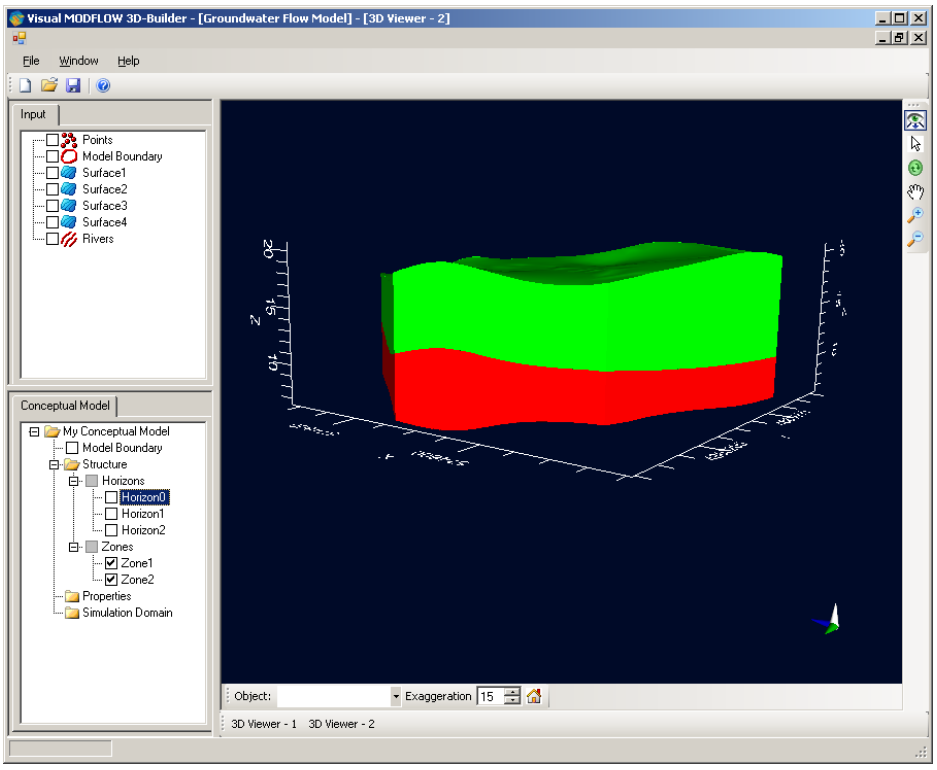
1. With a 3D Viewer Window opened, expand the **Horizons** node in the **Conceptual Model** tree and select the box ☐ beside each horizon name so that it appears checked ☑



Viewing Structural Zones

Structural Zones are generated automatically when horizons are created. To view structural zones in a 3D-Viewer, follow the steps below:

1. With a 3D Viewer Window opened, expand the **Zones** node in the **Conceptual Model** tree and select the box ☐ beside each zone name so that it appears checked ☑



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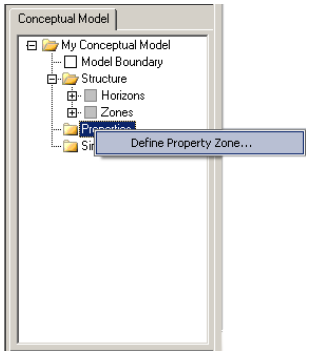
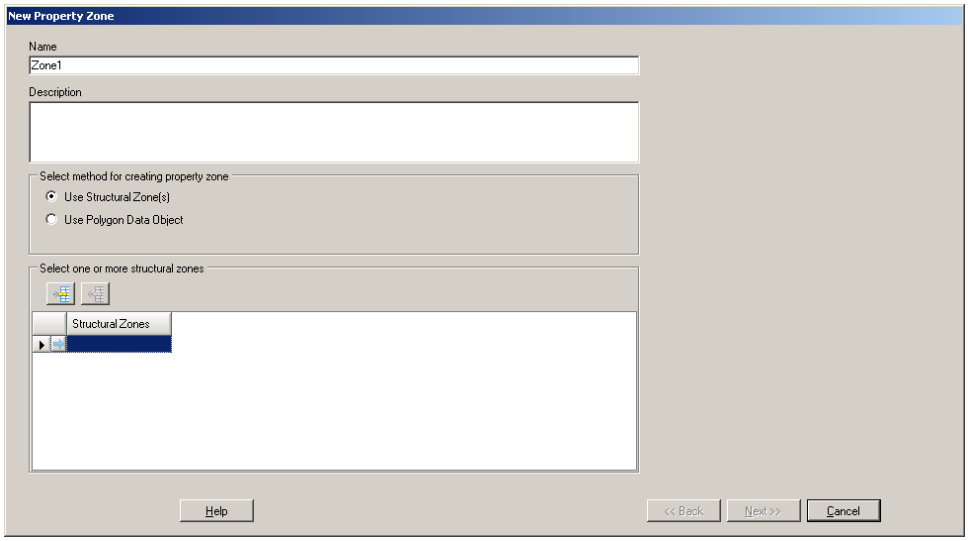
Creating Property Zones

1. From the **Conceptual Model** tree, right-click on the **Properties** node and select **Define Property Zone**



2. Upon clicking, the **New Property Zone** dialog will display:



Name
Type in a unique name for the property zone

Description *(Optional)*
Type in a description of the property zone

Select method for creating property zone
Select a method by clicking the desired radio button. This guide describes the steps for the **Define property zone using structural zone** method. For information on defining property zones using a polygon data object, please refer to the 3D Builder User's Manual.

Select one or more structural zones
From the **Conceptual Model Tree**, select a structural zone, and then click the button.

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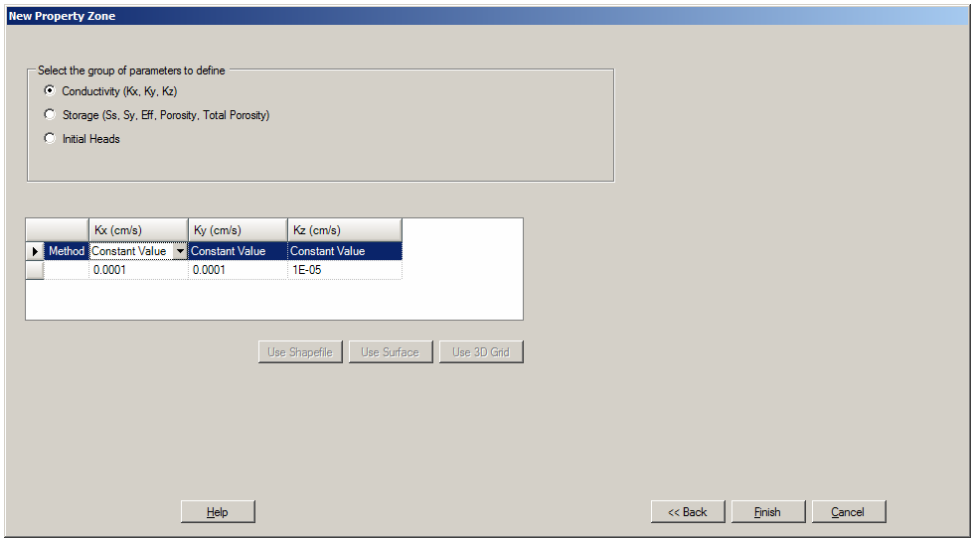
3. Click the **[Next]** button to continue.



4. Select the group of parameters for which attributes will be defined, *e.g.,* conductivity, storage or initial heads.

5. In the data input grid, select the method for each parameter from the **Method** combo box, *e.g.*, **Constant Value**, **Use Surface**, **Use 3D-Gridded Data**. For more information on the different methods for assigning attribute values, please refer to the User's manual.

6. Assign values to each parameter according to the specified method. For example, if you selected constant value for an attribute, specify a constant value in the value field. If you selected use surface method for an attribute, click the **Use Surface** button, and specify a surface data object from the **Input** tab.

7. Once values have been assigned, click the **[Finish]** button to create the property zone.

8. Repeat the steps above to create additional property zones.

   The created property zone will now appear under **Properties** node in the **Conceptual Model Tree.** You can view the property zone in **3D Viewer Window** by checking the white box beside the property.

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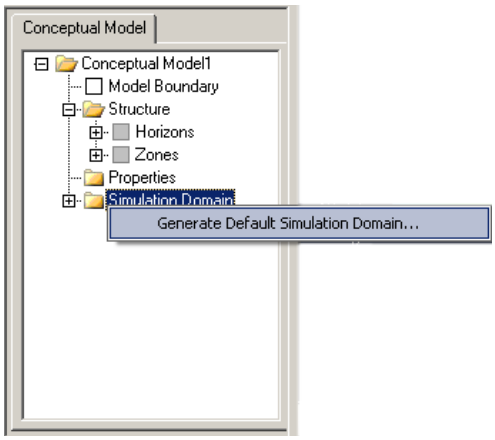
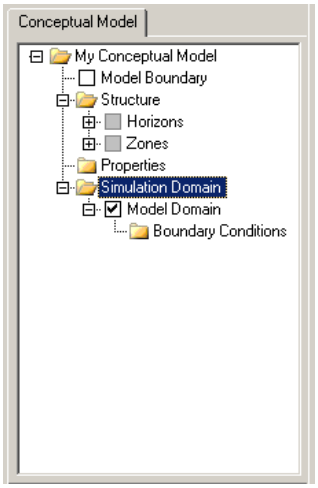
Defining the Simulation Domain

To define a simulation domain, follow the steps below:

1. From the **Conceptual Model Tree**, right-click on the **Simulation Domain** node, and select **Generate Default Simulation Domain** from the pop-up menu.



2. Expand the **Simulation Domain** node. You will see that it has created the "**Model Domain"**; this volume is defined by the conceptual model area and the upper-most and lower-most horizons.



3. If a 3D Viewer window is opened, you can view the geometry of the simulation domain by selecting the white box located beside the "**Model Domain**" node.

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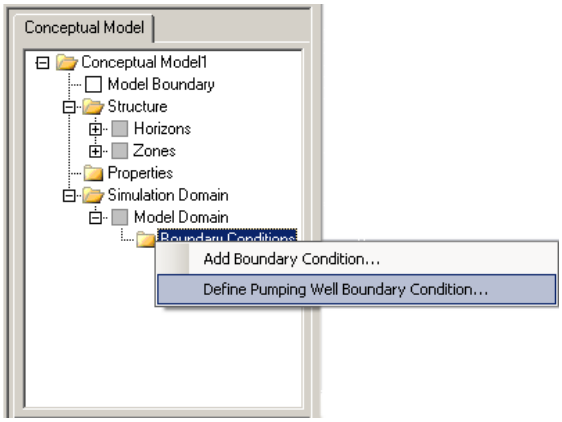
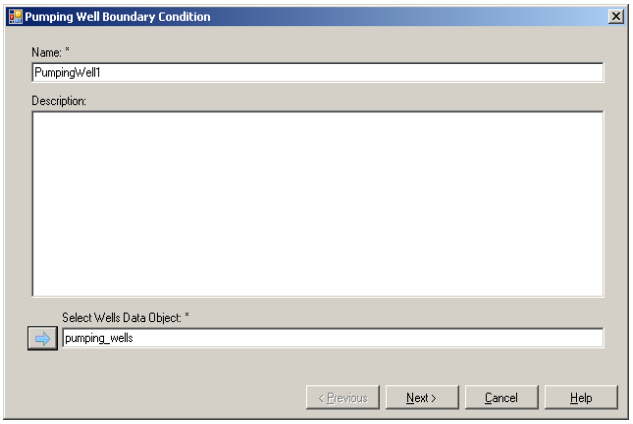
Defining Pumping Wells

Before you can create pumping wells, you must import a wells data object into your 3D-Builder project. To define pumping wells, follow the steps below.

1. Right-click on the **Boundary Conditions** in the conceptual model tree, and select **Define Pumping Well Boundary Condition** from the pop-up menu.



2. Upon selecting, the following dialog will appear. Enter the following data:

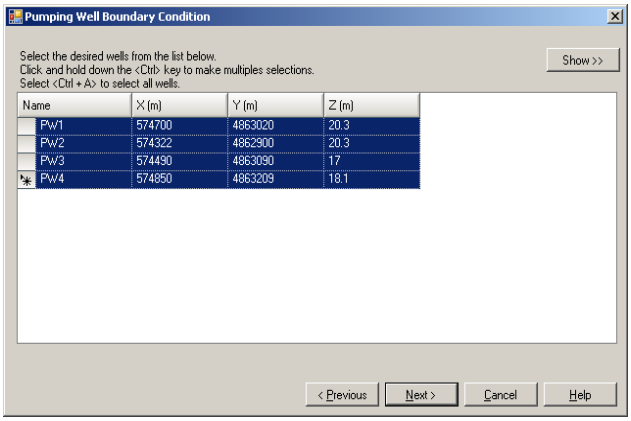


Name
Type in a unique name for boundary condition.

Description *Optional*
Type in a description of the boundary condition.

Select Wells Data Object
Select a wells data object from the **Input** tab, and then click the button.

3. Click the **[Next]** button to proceed to the next step. The following dialog will display:



This dialog displays all the pumping wells for the selected wells data object.

Here you can select which pumping wells to include in the boundary condition. By default, all wells will be selected (highlighted blue), however, you can select the desired wells by holding the **[CTRL]** key and clicking each well.

Click the **[Show>>]** button to view a preview of the wells in a 3D Viewer window.

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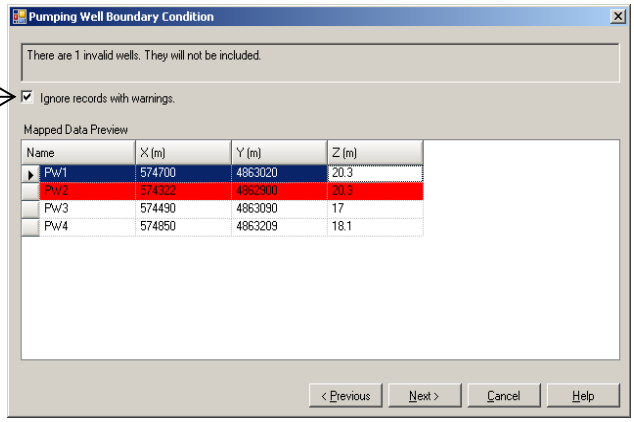
4. Click the **[Next]** button to proceed to the next step. The following dialog will display:



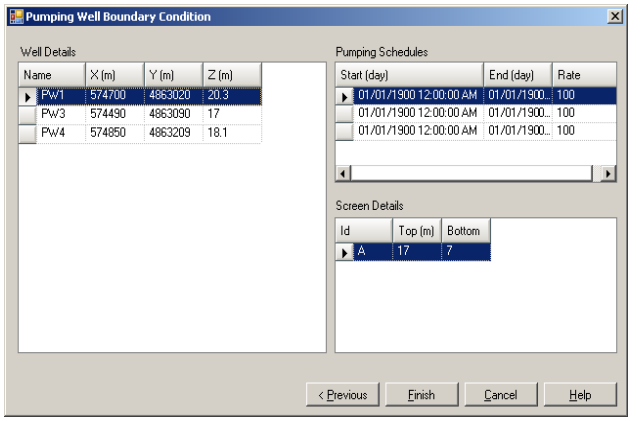
Check this box to ignore all invalid pumping wells.

At this step, each pumping wells is validated to ensure that the following requirements are met:

- The pumping well coordinates must fall within the conceptual model boundary domain
- The pumping well must have a defined pumping schedule
- The pumping well must have a defined screen.

If a well does not meet all of the above requirements, it is colored red in the **Mapped Data Preview** table.

5. Click the **[Next]** button to proceed to the next step. The following dialog will display:



Here you can preview the pumping schedule and screen details for each pumping well. Simply select a pumping well from the **Well Details** table, and the corresponding pumping schedule and screen details will be shown in the adjacent **Pumping Schedules** and **Screen Details** table.

Note: The data shown in this dialog is read-only. If you want to make changes to the pumping schedule or screen information, you can do so using the pumping well data table. For more information on modifying well data, please refer to the User's Manual.

6. Click the **[Finish]** button to generate the boundary condition. The boundary condition will now appear under the Boundary Conditions node in the conceptual model tree, and can be viewed in a 3D-Viewer or 2D-Viewer window.

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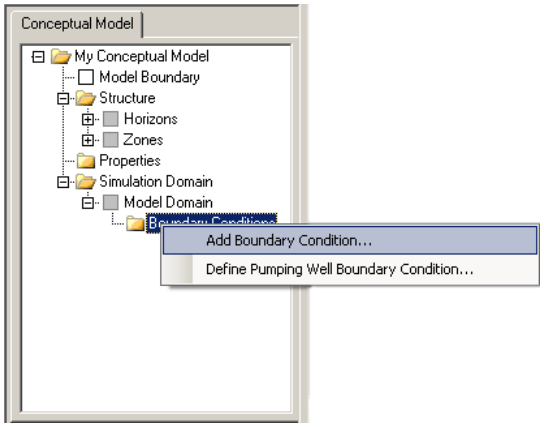
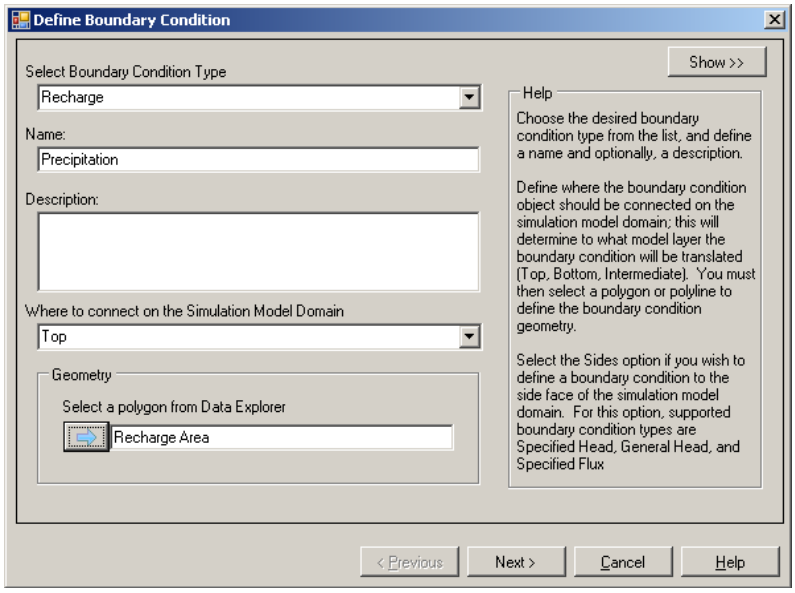
Defining a Recharge Boundary Condition

To create a recharge boundary condition, follow the steps below:

1. Right-click on the **Boundary Conditions** in the conceptual model tree, and select **Add Boundary Condition…** from the pop-up menu.



2. The **Define Boundary Condition** dialog box will appear on your screen (shown below).



- Select **Recharge** from the **Select Boundary Condition Type** combo box
- Specify a **Name** and optionally a **Description**
- Select the location of the boundary condition from the **Where to connect on the Simulation Model Domain** combo box. For Recharge boundary conditions, the available options are **Top** and **Intermediate.**
- From the **Input** tab, select a polygon data object that represents the recharge area and click the **Blue Arrow** button.

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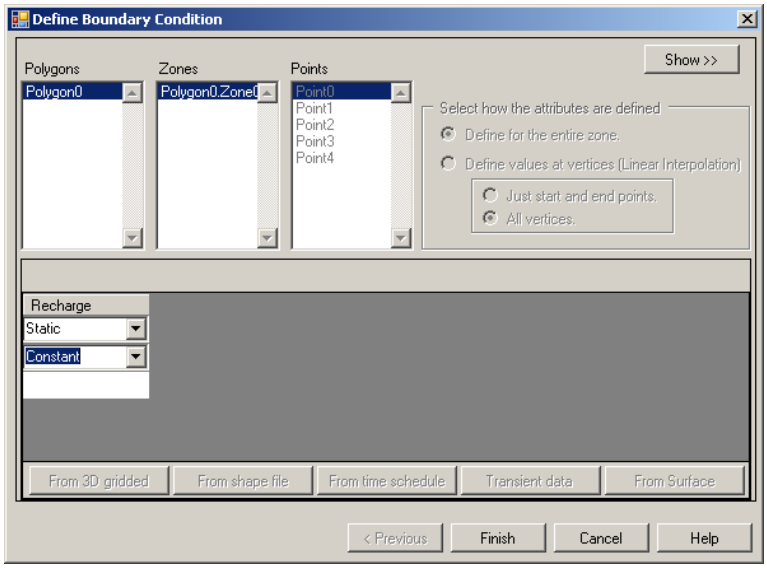
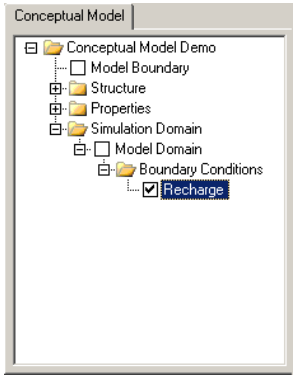
3. The next step involves assigning boundary condition parameters.



- For the Recharge parameter, select either **Static** or **Transient** from the first combo box. If **Static** is selected, proceed to the next step. If **Transient** is selected, select the **Transient Data** button, and define the appropriate stress periods and recharge values.
- Select an option from the second combo box. For recharge, you can select from **Constant**, **Use Surface**, **Use Shapefile** or **Use Time Schedule**.
- If **Constant** is selected, type a recharge rate in the empty field. The recharge value must be entered in the units specified in your project settings. If **Use Surface**, **Use Shapefile** or **Use Time Schedule** is selected, you can assign parameters using data from an imported data object. For more information on these methods, please refer to section "Specifying Boundary Condition Data" in the 3D-Bulder User's Manual.
- Once the recharge parameter has been assigned, click the **[Finish]** button to complete the boundary condition creation process.

  The new Recharge boundary condition will be added to the Conceptual Model tree, under the Boundary Conditions node. From here you can display the boundary condition in an opened 3D Viewer.



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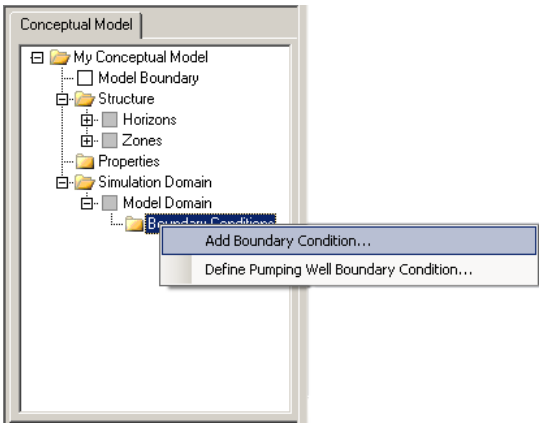
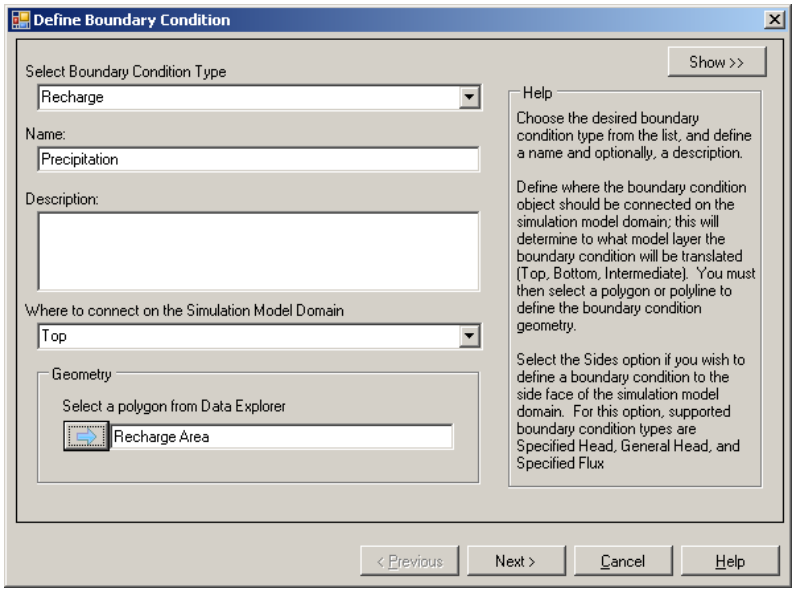
Defining a General Head Boundary Condition

The following steps describe the workflow for adding a general head boundary condition to the side of the simulation domain.

1. Right-click on the **Boundary Conditions** in the conceptual model tree, and select **Add Boundary Condition…** from the pop-up menu.



2. The **Define Boundary Condition** dialog box will appear on your screen (shown below).



- Select **General Head** from the **Select Boundary Condition Type** combo box
- Specify a **Name** and optionally a **Description**
- Select the **Side** option from the **Where to connect on the Simulation Model Domain** combo box.
- Click the **[Next]** button to continue.

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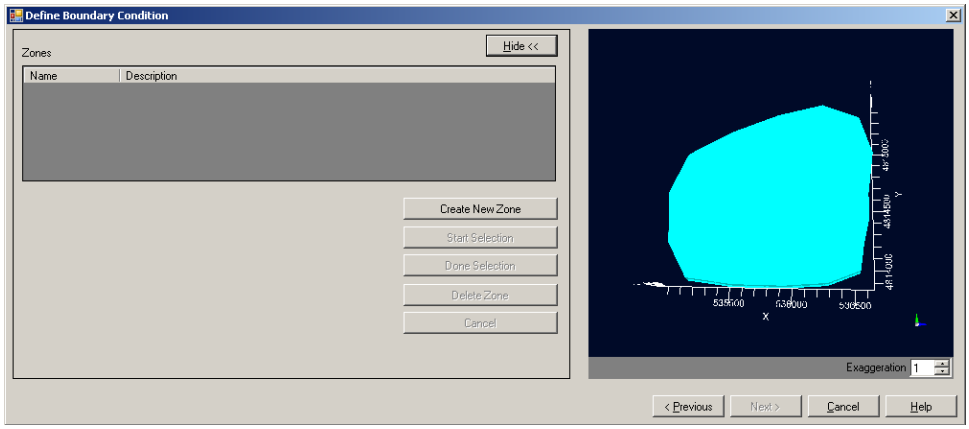
3. The next step involves manually selecting the desired sides of the simulation model domain using an interactive 3D Viewer.



- Click the **[Show]** button to display the interactive 3D Viewer.
- Click the **[Create New Zone]** button. A new row will be added to the Zones table, where you can change the zone **Name** and **Description**.
- Click the **[Start Selection]** button. A new combo box called **Selector** will be added to the bottom of the interactive 3D Viewer.
- From the **Selector** combo box, select **Facets.**
- In the 3D Viewer, rotate the simulation model domain so that you are able to see the sides.
- Increase the vertical exaggeration as desired.
- Hold the **[CTRL]** button, and select the desired sides on the simulation model domain. Once the selection is finished, click the **[Done Selection]** button.
- Click the **[Next]** button to continue.

4. The next step involves assigning boundary condition parameters. The workflow for this step is very similar to **Step 3** described in the previous section for creating a recharge boundary condition. Please refer to this section, or the 3D-Builder User's Manual for more information on assigning attributes to boundary conditions.

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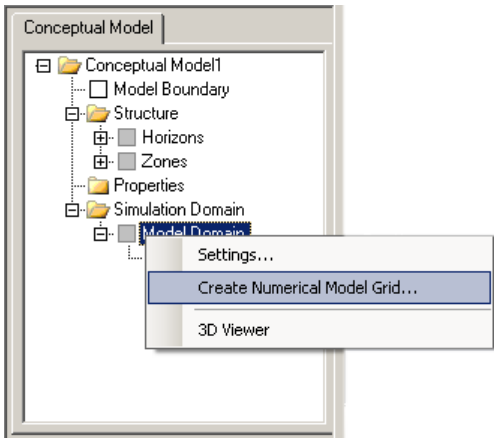
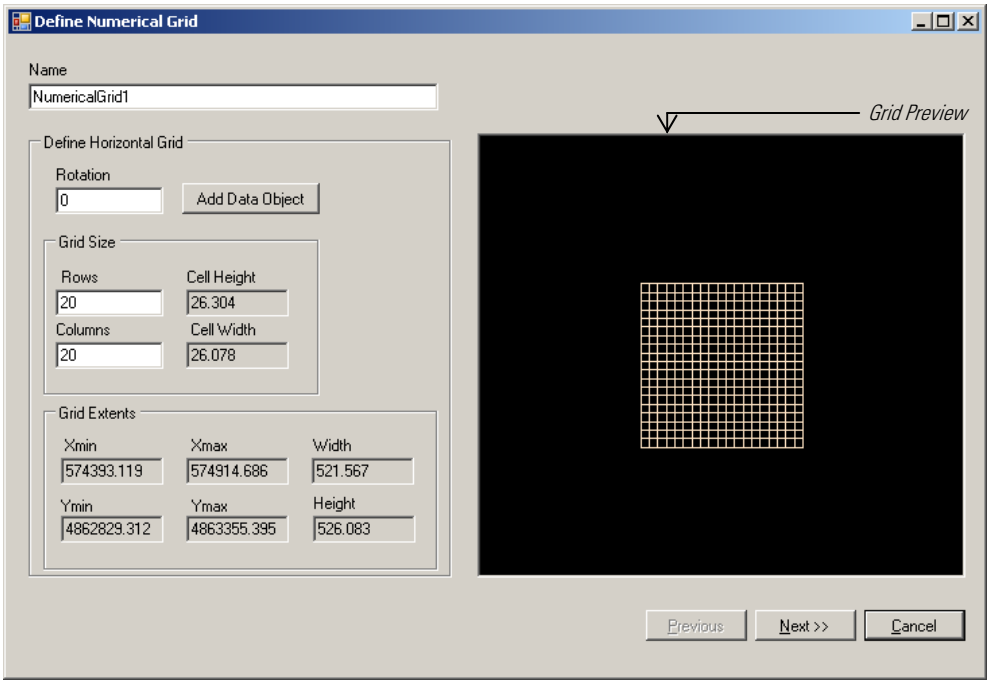
Defining a Numerical Model Grid

To create a new numerical model grid, follow the steps below:

1. Right-click on the model domain and select **Create Numerical Model Grid** from the pop-up menu.



2. The following dialog will display. Here you can define the horizontal grid properties including the **grid origin**, **rotation** and the **number of columns** and **rows**.



Use the scroll-wheel on your mouse to zoom in and zoom out of the grid preview

For more information on the grid settings, please refer to the User's Manual. Once the settings are defined, click the **[Next]** button to continue to the next step.

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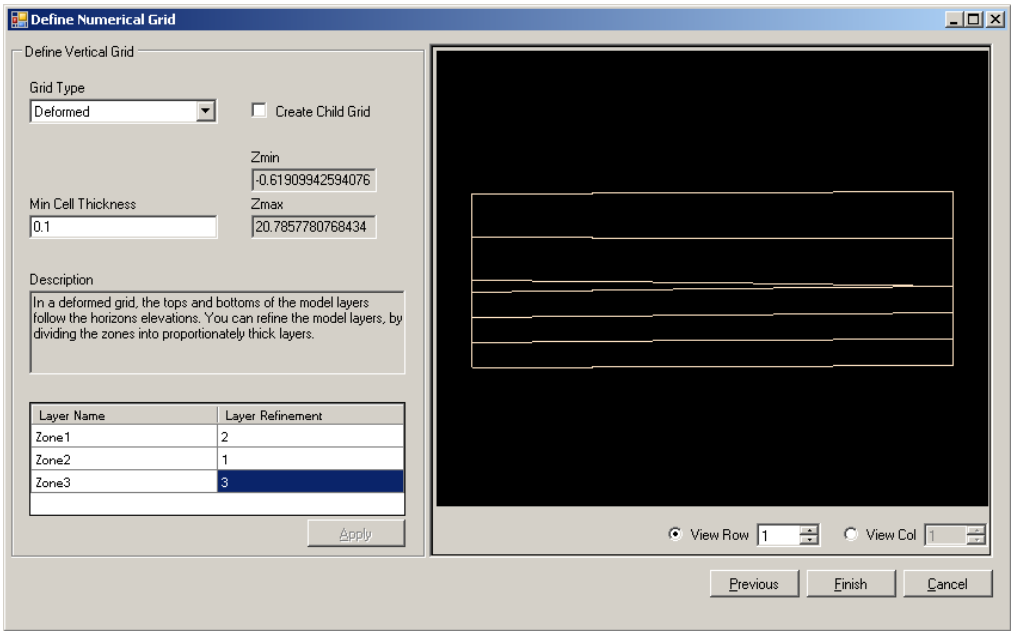
3. The following dialog will appear. Here you can define the vertical grid settings by selecting the **Grid Type**. For more information on the various grid types, and their respective settings, please refer to the User's Manual.



4. Click the **[Finish]** button to create the numerical grid. Once created, you can view the grid in a **3D-Viewer** window.

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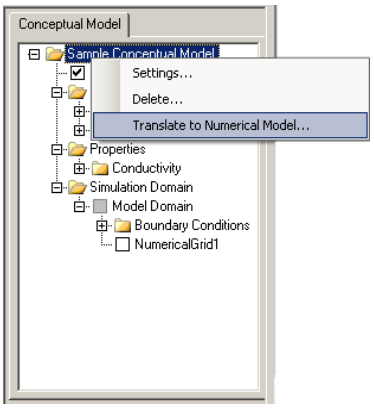
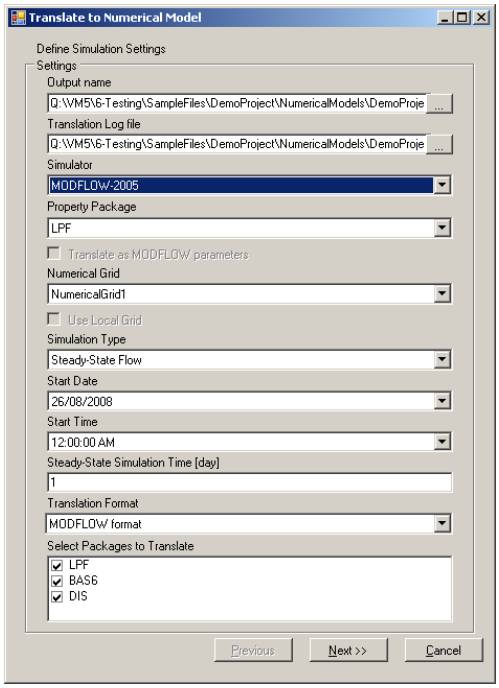
Translate to a Numerical Model

To translate your conceptual model to a numerical model, follow the steps below:

1. Right-click on the root of the **Conceptual Model Tree** and select **Translate to Numerical Model…** from the pop-up menu.



2. Define the appropriate **Simulation Settings** from the **Translate to Numerical Model** dialog box. Each setting is described in more detail in the 3D-Builder User's Manual. Once defined, select the **[Next]** button to continue.



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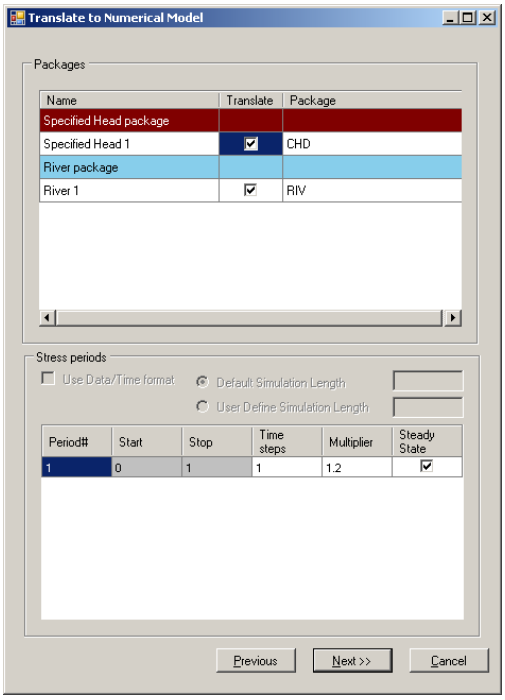
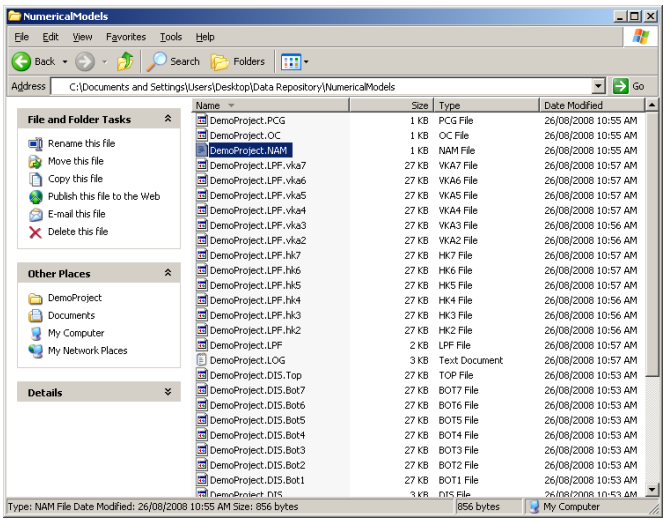
3. In the **Packages** frame, specify which boundary conditions to include/exclude in the translation. In the **Stress Periods** frame, specify the number of **Time Steps** and the **Multiplier** value, for each calculated stress period. Use the **Steady State** column to set the stress period as steady-state. For more information on the packages and stress period options, please refer to the User's Manual. Click the **[Next]** button to begin the translation.



4. During translation, the generated MODFLOW input files are saved to the data repository in a new subfolder called **NumericalModels**. The MODFLOW data set can now be imported into Visual MODFLOW for running the simulation.



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Importing Into Visual MODFLOW

Once you have translated your conceptual model to a numerical model, you can import the generated MODFLOW data set into Visual MODFLOW 4.3 and then run the model.

To import the MODFLOW data set into Visual MODFLOW, follow the steps below:

1. Launch the Visual MODFLOW application by double-clicking on the desktop shortcut or by selecting it from the Window's start menu.

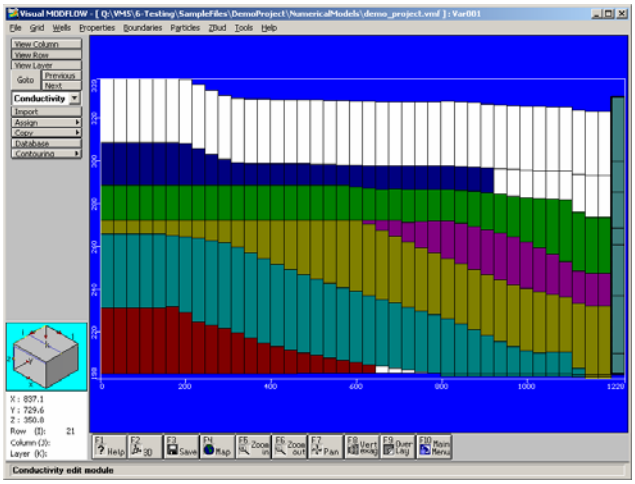
2. Select **File / Import MODFLOW** from the top menu bar, and then choose the .NAM file of model data set (located in the data repository, in the NumericalModels folder) Click the **[Open]** button.

3. Next, enter a name for the Visual MODFLOW model data files. Once entered, click the **[Save]** button.

4. The model data file selection window will appear. Select the data files to include in the imported model and then click the **[Next]** button to continue.

5. A preview of the layer settings for the imported model will be displayed. Once you have verified the layer dimensions, click the **[Next]** button.

6. Finally, specify the appropriate **Start Date** and **Start Time**, and the units for **Conductivity**, **Pumping Rate** and **Recharge**. These settings must match the settings specified in 3D-Builder. Finally, click the **[Finish]** button to complete the import process.



Once the model is imported, you can make further modifications to the model using the features available in Visual MODFLOW, or you can simply run the model. For information on how to run models in Visual MODFLOW, please to refer to Chapter 2: Section 2.2.2 "Importing a MODFLOW data set" in the Visual MODFLOW User's Manual.

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Table of Supported Data Types

Data Type	Supported File Types	Description	How can it be used in 3D-Builder?
Points	.XLS, .MDB, .DXF, .TXT, .CSV, .ASC	Discrete data points with known attribute(s), e.g., X, Y, elevation, top/bottoms of formations, Kx, Initial Heads.	Interpolate the points to generate surfaces, which can be used for defining conceptual model horizons, or distributed parameter values such as Kx, Initial Heads, Recharge, etc.
Polygons	2D/3D ESRI Shapefile, AutoCAD DXF	GIS vector files containing polygon geometry and attributes	Use to define the conceptual model domain Use to delineate property zones Use to define geometry of aerial boundary conditions, e.g., lake, recharge, specified-head.
Polylines	2D/3D ESRI Shapefile, AutoCAD DXF	GIS vector files containing line geometry and attributes	Use to define geometry of linear boundary conditions, e.g., river, drain, general head
Surfaces	USGS .DEM, ESRI ASCII Grid (.ASC, .GRD), Surfer .GRD (ASCII or Binary)	Files containing an ordered array of interpolated values at regularly spaced intervals that represent the spatial distribution of an attribute, e.g., digital elevation model	Use to define conceptual model horizons Use to assign spatially-variable attributes to boundary conditions and property zones
Wells	.XLS	Well head coordinates (X,Y,Z) and associated well attribute data such as screen intervals, pumping schedules, observation points and data, well tops (contact points with geological formations), and well path (for deviated wells)	Interpolate well heads to generate a surface representing topography Convert well tops to surfaces representing top/bottoms of geological formations Use to define pumping well boundary conditions
Time Schedules	.XLS	Attributes measured over time, e.g., hydrographs	Use to define transient data for boundary conditions, such as recharge, river stage elevations
Maps	.JPG, .BMP, .TIF, .GIF	Raster images, e.g., aerial photographs, topographic maps, satellite imagery	Use sitemaps for gaining a perspective of the dimensions of the model, and for locating important characteristics of the model
Cross Sections	HGA-3D Explorer (.3XS)	Cross sections generated using Hydro GeoAnalyst data management software	Generate surfaces from cross section model interpretation layers and use for defining model horizons/structural zones
3D Gridded Data	TecPlot .DAT, MODFLOW .HDS	3D Grids with attributes at each grid cell	Use to visualize heads data generated from a MODFLOW run in Visual MODFLOW. Use to assign spatially-variable attributes to boundary conditions and property zones

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